

Global Aerospace & Airlines

Consumers' climate awareness on the rise; assessing the impact on traffic and planes demand

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Climate change awareness could slow US&EU passenger growth to 1.3-1.5% pa

Historically global air travel has grown at c. 4-5% pa and doubles every 15 years. Industry forecasts (Airbus, Boeing, Teal Group) expect the growth to remain within this range over 2019-2035 with intra-EU traffic growing at 3% and 2.1% for intra-US (source: Airbus GMF 2019). In this report, we assess the potential reduction to traffic and aircraft demand that could be triggered by a change of flying habits in the US and Europe on the back of growing stop climate change movements. This note is a follow-up on the back of our [Q Series: Green Power: Will climate change propel the sector towards Hybrid Electric Aviation by 2028?](#)

Lower growth would reduce small jet demand in EU/US by c.105 units pa

UBS Evidence Lab recent (Jul-Aug) survey of 6,097 respondents shows a growing share of travellers across the US (24%), France (23%), UK (16%), Germany (23%) reducing their air travel by at least one or more flights in the last 12M on environmental awareness. Higher "eco" taxes (see France, Germany, Switzerland), CORSIA, will weigh on airlines' economics and demand elasticity. On Friday California has approved New Temporary Pathway for Alternative Jet Fuel allocating higher carbon credits to bio-fuels. We simulate the impact of this behaviour for European and US intra-regional aircraft demand. Compared to Airbus GMF 2019, we estimate that the small jet future demand in these regions could reduce to 426 units pa vs 534 currently estimated.

Green aviation initiatives and opportunities growing exponentially

Green Power aviation in our view will be a combination of various technologies – bio fuels (esp for long-haul), battery technology evolution particularly for solid states and fuel cells. Since the Paris Airshow, Aerospace players have increased their investments in technology and start-ups, which we view as supportive of our view which could see a hybrid-electric plane of 50-70 seats by 2028.

Impact for Airbus and Boeing could be a loss of c.110 narrow-body planes pa

Assuming 57% market share, the impact to Airbus could be c.€2.8bn of lost annual revenues, c.€500mn EBIT which represents c. 7% of UBS est. Airbus commercial FY20E EBIT of €7.3bn. To counter this mid-term risk, we reiterate our view that OEMs should invest in hybrid and electric technologies to further reduce aviation carbon footprint.

By how much could US & EU traffic growth reduce on climate concerns?

We simulate the impact of a potential change in flying habits across the US and Europe air travel and what it would imply for jet demand. It is appropriate in our view to integrate a higher likelihood of air passengers' behavioural change on the back of raising climate change awareness, in particular in Developed Markets.

We gain renewed comfort from the results of a UBS Evidence Lab survey conducted in July-August 2019 across four developed nations (UK, France, Germany, US). The US and Europe accounted for 40% of the passengers carried in 2018 (Figure 1), if we were to add Japan, Canada, Australia and New Zealand we would get close to 47%. In our analysis we have focused on North American and European consumers' behaviours and traffic growth.

Figure 1: Passengers carried in 2018 and trips per capita

Region	Total passenger carried in 2018 (mn)	Trips per capita (2018)
World	4,233	0.6x
USA	889	2.7x
EU	802	1.6x
Japan	126	1.0x
Canada	89	2.4x
Australia	76	3.0x
New Zealand	17	3.5x

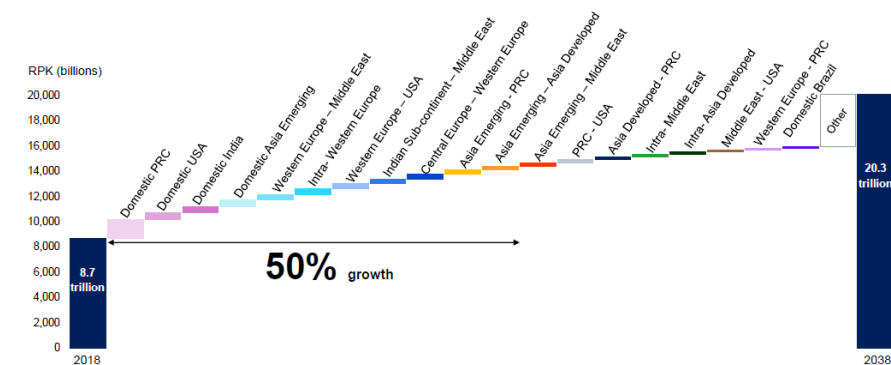
Source: ICAO, World Bank

At this stage we think that EM countries will continue to be driven by economic development, spreading consumer wealth and a growing middle-class. One exception could be China over time. President Xing has a clear driven agenda to curb emissions. Aviation is not in the picture at this stage, but China could further develop its high-speed train network to reduce domestic flights, leading potentially to a reduction in its dependency on Airbus and Boeing until China has an indigenous medium-haul plane.

Figure 2: Airbus expect Intra-Western Europe and Domestic USA to remain among the top 6 traffic flows over the next 20 years.

Traffic is forecast to grow at 4.3% p.a.

World annual traffic (RPK billion) with main growing flows



Source: Airbus GMF 2019

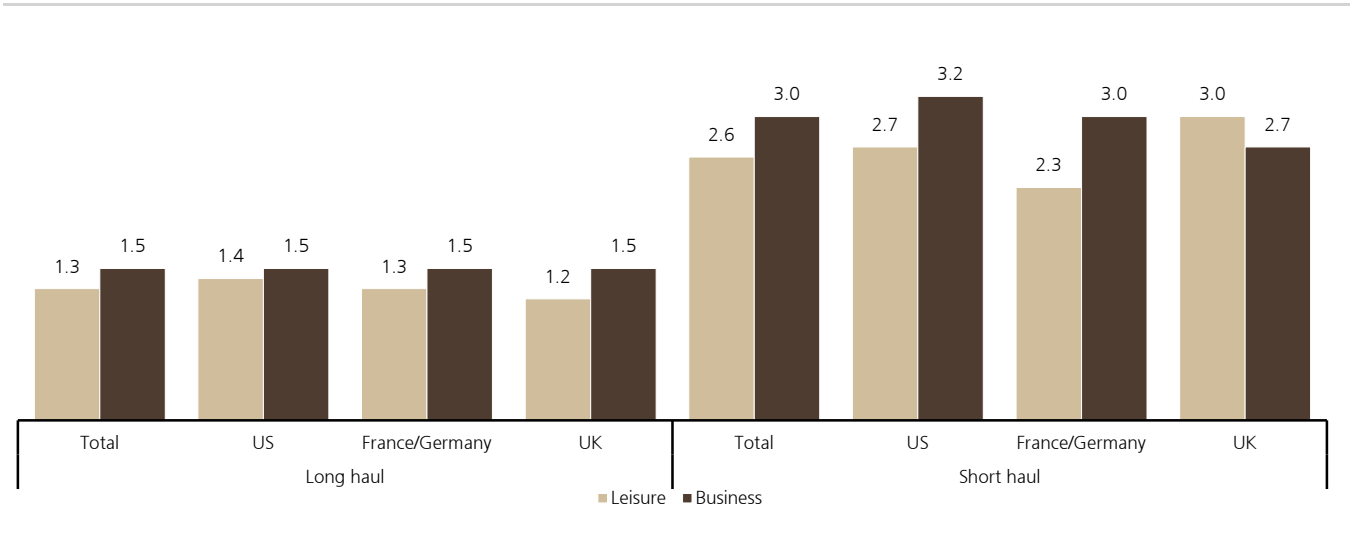
EM traffic matters a lot for growth, but DM traffic contribution remains in the top 6 traffic flows as per Airbus GMF 2019

UBS Evidence Lab Survey shows increased consumer focus on environment and air travel

UBS Evidence Lab conducted an online survey among a representative panel of consumers across the US, UK, France and Germany from 26th July to 6th August, 2019. In total 6,097 consumers completed the survey with approximately 1/4 in each of the four countries (US N=1509; UK N=1541; France N=1522; Germany N=1525). These countries are in our view most likely to embrace the environmental agenda further. The responses of the survey are very similar to those we gathered in our May 2019 survey ([Q Series: Green Power: Will climate change propel the sector towards Hybrid Electric Aviation by 2028?](#)) but the previous geographical sample was just on US and Germany.

Across our sample, on average for leisure purposes participants took 3.9 flights in the last 12 months, and 4.5 trips for business purposes; on short-haul specifically on average 2.6 leisure flights and 3.0 business ones (Figure 3).

Figure 3: Number of long/short haul travels for business/leisure in the past 12 months



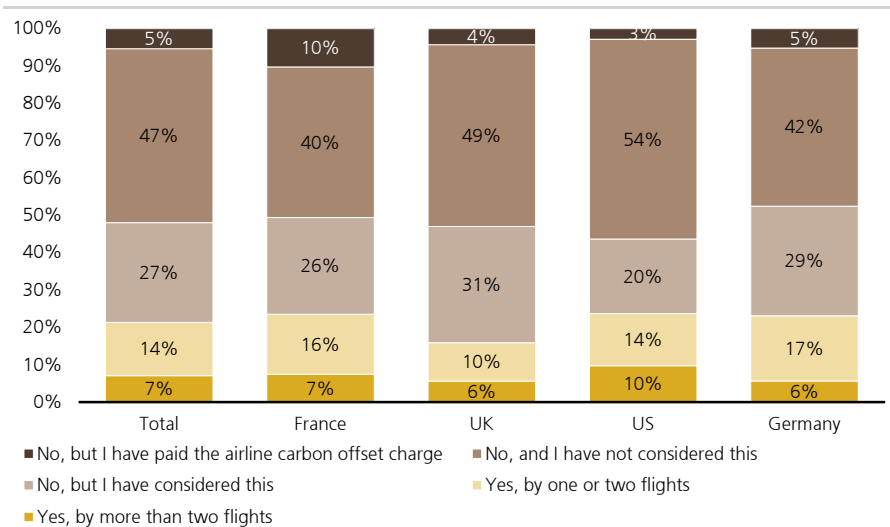
Source: UBS Evidence Lab

Around 21% of respondents admit having reduced their flights due to environmental concerns: **France, Germany and the US have scores at 23-24% respectively, whilst the UK is lagging at c.16%. Compared to the May-2019 survey, there is an increase in the share of US respondents who have reduced their air travel over the last 12M from 19% to 24% whilst Germany was at 25% vs 23% currently.**

To quote an extreme, Swedish air travel fell by c.10-11% year-on-year on domestic routes over the summer, international traffic fell 2-3%.

24% of US respondents acting on reducing their annual flights on climate concerns as much as France and Germany; UK lagging. 27% of respondents "thinking about it" up from 20% in May.

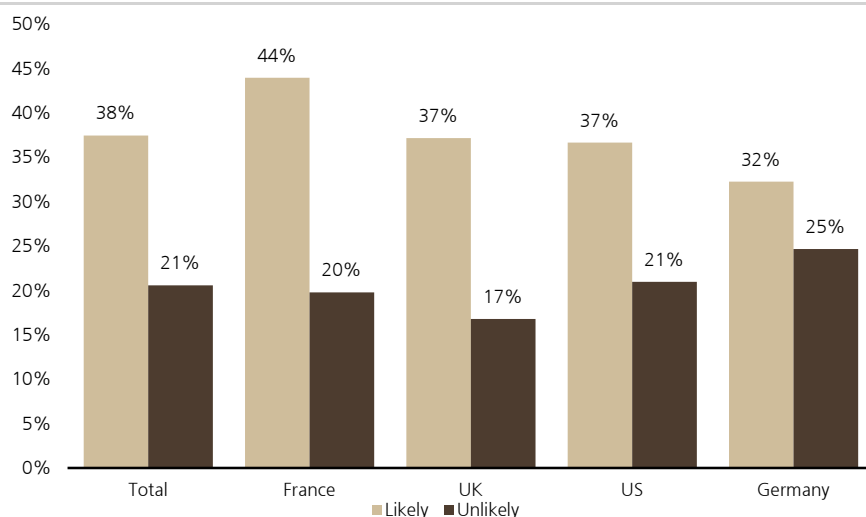
Figure 4: 21% of respondents admit to having reduced number of flights due to environmental concerns – strong increase in US behaviour



Note: we have taken out the "no opinions" from total
Source: UBS Evidence Lab

Our May 2019 survey highlighted that up to another 20% of respondents were "thinking of" reducing their flying on climate change concerns, this number has grown to 27%. With the pace of the climate change debate, we think it is fair to assume that these trends are likely to continue in developed markets. 38% of respondents would favour using hybrid electric planes compared to using trains or cars – with 44% in France and 32% in Germany. Our first survey also confirmed the entrenched habit of using trains and cars in Germany.

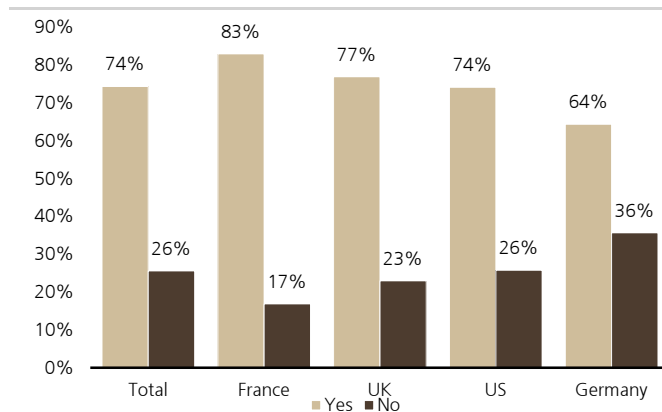
Figure 5: 38% of respondents are likely to fly on a hybrid or electric plane instead of driving their cars or taking the train, compared to 21% unlikely



Source: UBS Evidence Lab

The public perception of the hybrid-electric technology and its level of acceptance (theoretical) remain well above single-pilot aircraft.

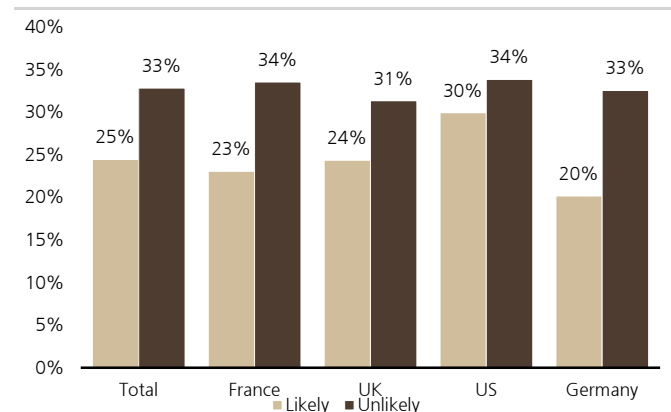
Figure 6: 74% of respondents agreed to consider flying more if hybrid or electric plane was available in place of a traditional plane



Note: we exclude the "no opinions" responses

Source: UBS Evidence Lab

Figure 7: ...this is in contrast to just 25% of respondents who are likely to fly a single pilot plane



Note: we exclude the "no opinions" responses

Source: UBS Evidence Lab

Intra EU, US traffic growth could drop to 1-1.5%pa...

As of the latest Airbus GMF 2019-2038, global traffic is expected to grow at c.4.3%pa over 2019-2038 with European domestic/intra-regional travel to grow at 3.0%pa and US domestic/intra-regional to grow at 2.1% pa. The table below breaks down the traffic growth expectations presented in the Airbus GMF 2019 by regions and mostly focused on developed markets where we focus our analysis.

Figure 8: Airbus GMF Traffic growth and new deliveries – Europe, North America and Total

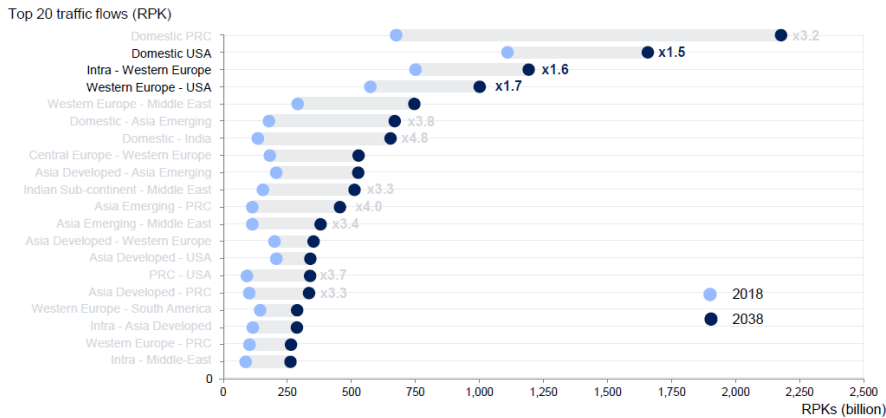
	RPK growth (% y/y)		Fleet in service		New deliveries by segment		
	2018	2019 -2038*	2018	2038	Small	Medium	Large
Europe	6.6%	3.3%	4,870	8,885	5,760	1,035	640
Intra -regional and domestic		3.0%					
Inter -regional		3.4%					
North America	5.0%	3.0%	4,690	7,145	4,910	695	360
Intra -regional and domestic		2.1%					
Inter -regional		3.6%					
Total	5.3%	4.3%	22,680	47,680	29,720	5,370	4,120

Source: Airbus GMF 2019, IATA

Note: * CAGR

Figure 9: Over the next 20 years Domestic US and Intra-Western RPK should be 1.5-1.6 x current size...it may be slower than this if the "Flying Shame" followers grow

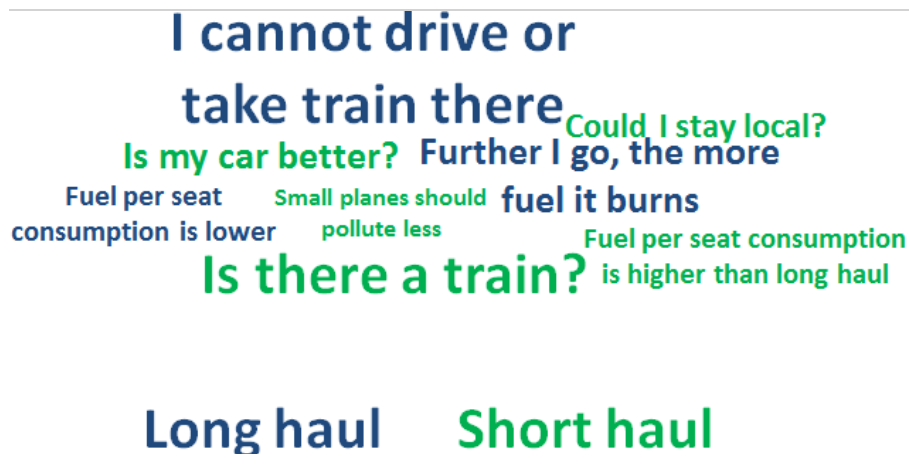
Traffic is forecast to grow at 4.3% p.a.



Source: Airbus GMF 2019

It is difficult to know if consumers are more likely to reduce long-haul or short-haul flights on climate concerns. There is a great variance in consumers' opinions and perceptions in each case. In our analysis, we allocate the reduction of flights to short-haul travel (under five hours) which corresponds generally to the narrow-body aircraft market (up to 200-210 seaters).

Figure 10: Variance of consumer perception to replacement of long-haul and short-haul flights by hybrid electric planes



Source: UBS estimates

Even if consumers are not proactively reducing travel for climate change, the recent increase (or planned increase) in eco travel taxes could reduce travel demand:

- France eco tax is starting from €1.5 per ticket on domestic flights up to €18 for long-haul business tickets,
- Germany just recently decided to increase short-haul flight taxes to offset reductions in train fares. The current €7.38 (\$8.10) per-passenger tax for flights departing German airports will double from January 1, 2020, the additional

Swedish domestic travel was down by 3.4% in 2018, in July and August 2019 domestic air traffic was down 10-11%. International travel was down 2-3% over June-August 2019 (source: Swedavia)

revenue funding a cut in Value-Added Tax (VAT) on rail tickets from today's 19% to 7%,

- Switzerland MPs have approved mid-September a flight tax ranging from CHF30 to CHF120 depending on class and distance travelled. The tax will be introduced if the Senate approves it too.

According to the European Commission the weighted average aviation tax in the EU across all Member States and destinations amounts to € 11 per ticket. **If all aviation taxes in the EU were abolished, the number of passengers would increase by 4%.** This would result in an approximately equivalent increase in the number of flights, connections, jobs in the aviation sector and value added in the aviation sector. The CO₂ emissions of aviation would increase by 4% and the number of people affected by airport noise by 2%. Conversely, abolishing the exemption of energy taxation on aircraft fuel would, if it were possible, result in an increase of the average ticket price by 10% and a decrease in passenger demand of 11% (source: [Taxes in the field of Aviation and their impact June 2019](#)).

Based on our simulation below (Figure 9), we conclude that **intra-European traffic growth could reduce to 1.5% per year versus 3% currently forecasted** by Airbus in its 2019 GMF. We model a 2% annual increase of the share of passengers reducing their short-haul flights (under 5 hours) by two a year. For the US we use more conservative growth in the share of the population that reduces travel by two flights a year. Our starting assumption of 5.4 and 5.6 short-haul flights is from the UBS Evidence Lab survey. The **intra-US traffic growth reduces to 1.3% growth pa compared to the 2.1% growth** envisaged (Airbus GMF 2019).

Figure 11: Traffic growth could reduce to 1.3-1.5% pa (from 2.1-3%) for intra Europe and intra-North America travel if the "stop climate change" momentum continues

Inputs	
<i>Traffic</i>	
Current # of short-haul flights p.a. per passenger in Europe	5.4
Current # of short-haul flights p.a. per passenger in the US	5.6
Incremental % of passengers reducing flights p.a. in Europe	2%
Incremental % of passengers reducing flights p.a. in the US	1%
Degrassive # of flights p.a. for passengers reducing flights	2
Intra-regional and domestic traffic growth p.a. in Europe 2019-38 (Airbus)	3.0%
Intra-regional and domestic traffic growth p.a. in the US 2019-38 (Airbus)	2.1%

Small aircrafts deliveries model							
Europe	2019	2020	2021	2022	2023	2024	2025
Passengers reducing flights p.a. due to environmental concerns (%)	21%	23%	25%	27%	29%	31%	33%
Passengers not reducing flights (%)	79%	77%	75%	73%	71%	69%	67%
# of short-haul flights p.a. per passenger	5.6	5.7	5.9	6.1	6.3	6.4	6.6
# of short-haul flights p.a. per passenger with environmental concerns	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Implied # of short-haul flights p.a. per passenger	5.1	5.2	5.3	5.4	5.4	5.5	5.6
North America							
Passengers reducing flights p.a. due to environmental concerns (%)	21%	22%	23%	24%	25%	26%	27%
Passengers not reducing flights (%)	79%	78%	77%	76%	75%	74%	73%
# of short-haul flights p.a. per passenger	5.7	5.8	6.0	6.1	6.2	6.3	6.5
# of short-haul flights p.a. per passenger with environmental concerns	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Implied # of short-haul flights p.a. per passenger	5.3	5.3	5.4	5.5	5.6	5.6	5.7

Implied UBS traffic growth	CAGR 19-25	vs Base
Europe	1.5%	-51%
North America	1.3%	-38%

Source: UBS estimates, Airbus GMF 2019

...leading to a 7% reduction on overall small jet requirements

Our starting point is the Airbus GMF2019 forecast which allocates a requirement of 5,760 new small jets in Europe and 4,910 in North America over 2019-2038 out of a total 20-year demand of 38,360 new passenger aircraft. We annualise the NA and EU requirement and we assume that intra-regional fleet share is c.33% in Europe and c.50% in North America, in-line with the current share of the traffic.

Total intra-regional fleet requirement could be close to 1,453 small jets over the next six years, and it could drop by 45% to 818 units based on the traffic scenario of 1.3-1.5% annual growth. **Looking at overall global small jet new deliveries forecast in Airbus GMF2019, it would be a reduction of c.7%.**

Assuming 57% market share, the annual impact to Airbus could be c.€2.8bn of revenues and c.€500mn EBIT pa which represents c. 7% of UBS estimate for Airbus commercial EBIT of €7.3bn in FY20E. To counter this medium-term effect, we reiterate our view that OEMs should invest in hybrid and electric technologies to reduce aviation carbon footprint.

Figure 12: On annual basis 1.3-1.5% traffic pa growth in intra-EU/US, means those regions need 106 fewer small planes per year

Inputs		
<i>Production</i>		
New deliveries of small aircrafts in Europe by 2038 (Airbus)	5,760	
New deliveries of small aircrafts in the North America by 2038 (Airbus)	4,910	
New deliveries of small aircrafts for Europe intra/domestic flights by 2038	1,901	
New deliveries of small aircrafts for North America intra/domestic flights by 2038	2,455	
New deliveries of small aircrafts in Europe by 2025 (UBS)	634	
New deliveries of small aircrafts in the North America by 2025 (UBS)	819	

Implied UBS traffic growth	CAGR 19-25	vs Base
Europe	1.5%	-51%
North America	1.3%	-38%

UBS estimated impact of increased environment consciouness on flying		vs Base
Impact on European market production (units)	326	
Impact on NA market production (units)	309	
Total impact on production over 2019-25 (units)	635	
Implied new deliveries of small aircraft US+Europe by 2025	818	-44%
Impact on total annual production (units)	106	
Revenues annual impact per OEM (@57% market share AIR, €mn)	2,845	
EBIT annual impact @ 18% margin (€mn)	512	

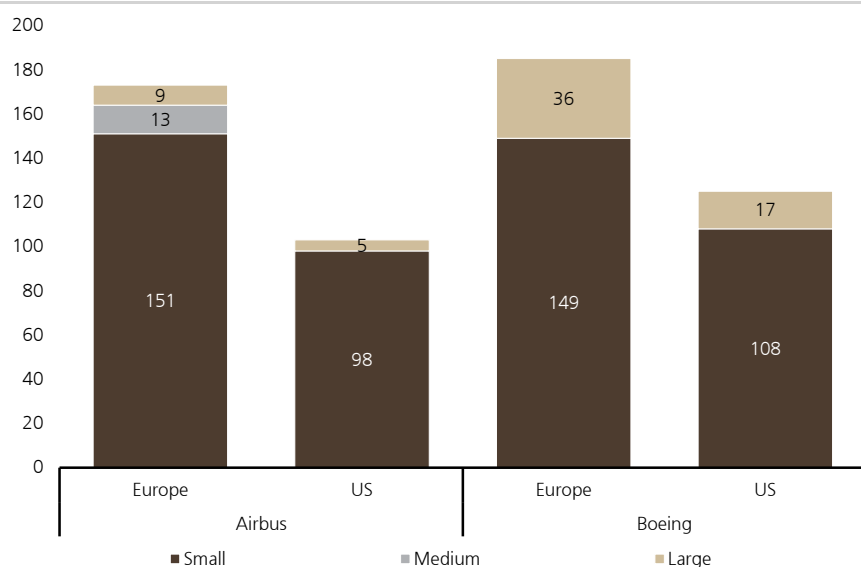
Source: UBS estimates, Airbus GMF2019

In 2018 23% of Airbus' small jet deliveries (A220, A320ceo and A320neo family) were operated in Europe and c.15% to North American operators. For Boeing those shares were closer to 25% and 19% respectively in 2018. So these two regions still represent a healthy share of the deliveries, going forward climate change concerns could reduce their shares further. This market appetite reduction could be managed as long as Airbus and Boeing remain in a duopoly with no competition in the Asian market or from a new entrant.

The annual impact could be 7% reduction in global small jet demand, and 7% impact to Airbus FY20E EBIT.

Policies that would accelerate old aircraft retirements would be beneficiary to the OEMs as replacement demand could offset slower growth. However so far there is little governmental action towards this. 90% of these old-generation planes' materials could be recycled.

Figure 13: In 2018 Airbus and Boeing delivered 1,541 small, medium and large passenger jets, of which 358 for European and 228 for US carriers



Source: Cirium; Note: Small – A220, A319, A320, A321, 737 NG and 737 MAX, Medium – A321neo ACF, A330 and 767, Large – A350, A380, 747, 787 and 777.

Our current Airbus and Boeing forecasts (Figure 14) do not include the potential reduction caused by increased climate change awareness. However we monitor the impact closely.

Figure 14: Airbus and Boeing historical and forecast deliveries

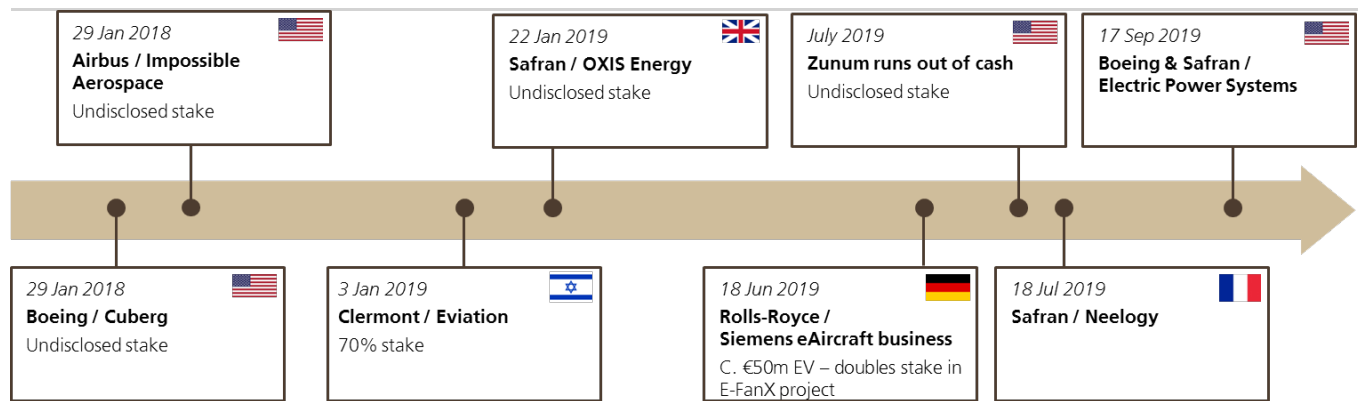
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019E	2020E	2021E	2022E	2023E
Airbus														
A319ceo	51	47	38	38	34	24	4	10	8	0	0	0	0	0
A320ceo	297	306	332	352	309	282	251	185	133	60	10	0	0	0
A321ceo	51	66	83	102	144	184	222	183	99	40	15	0	0	0
A320 ceo family	399	419	453	492	487	490	477	378	240	100	25	0	0	0
A220	0	0	0	0	0	0	0	0	20	48	90	120	150	150
A319neo	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A320neo	0	0	0	0	0	0	68	160	284	400	380	410	450	450
A321neo	0	0	0	0	0	0	0	20	102	165	300	350	355	355
A320 neo family	0	0	0	0	0	0	68	180	386	565	680	760	805	805
A330ceo	87	87	101	108	110	103	66	67	46	9	0	0	0	0
A330neo	0	0	0	0	0	0	0	0	3	41	33	26	26	26
A340	4	0	2	0	0	0	0	0	0	0	0	0	0	0
A350	0	0	0	0	2	14	49	78	93	115	120	120	120	120
A380	18	26	30	25	30	27	28	15	12	8	4	0	0	0
Total Airbus	510	534	588	626	629	635	688	718	800	886	952	1,026	1,101	1,101
Growth YoY			10.1%	6.5%	0.5%	1.0%	8.3%	4.4%	11.4%	10.8%	7.4%	7.8%	7.3%	0.0%
Boeing														
737 (NG) - 600/700	366	365	411	440	485	494	493	455	324	68	20	20	20	20
737 MAX							0	74	256	211	820	739	664	664
747	0	9	31	24	19	18	9	14	6	5	5	5	4	0
767	12	20	26	21	6	16	13	10	27	37	36	36	26	20
777 ERF			83	98	99	98	99	74	48	44	30	14	10	5
777X									0	0	0	25	40	50
777 total	74	73	83	98	99	98	99	74	48	44	30	39	50	55
787	0	3	46	65	114	136	139	136	145	162	168	168	168	168
Total Boeing	452	470	597	648	723	762	753	763	806	527	1,079	1,007	932	927
Growth YoY			27.0%	8.5%	11.6%	5.4%	-1.2%	1.3%	5.6%	-35%	105%	-6.7%	-7.4%	-0.5%

Source: UBS estimates

The technology momentum is accelerating


















Since the Paris Airshow in mid-June 2019, Aviation has increased its public discussions on environmental related technologies and not surprisingly we have seen a series of investments, partnerships and some failures (Zunum). The majority of our names spend a small amount of their Research and Technology for the hybrid-electric applications (ie. <€100mn pa at Airbus, <10% of R&D at RR) but we would expect this to increase over 2020-21. However the OEMs pursue constant weight-savings technologies in order to save fuel consumption which also helps efficiency.

Figure 15: Investment activity in hybrid-electric aviation seems to have picked up recently



Source: Company press releases, UBS

Figure 16: Top 6 initiatives out of 160-plus⁽¹⁾; Zunum is out of the race as Boeing backed away during the summer

Company					NASA	
Design						
HQ						
Category	Regional jets	Regional jets	Regional jets	Regional jets	Regional jets	Regional jets
Main characteristics	<ul style="list-style-type: none"> Hybrid/ Full-electric 300mph cruise speed 9 Passengers 	<ul style="list-style-type: none"> Hybrid/ Full-electric 7-9 Passengers Retrofitted Cessna 337 Skymaster 	<ul style="list-style-type: none"> Full-electric 186 Passengers 	<ul style="list-style-type: none"> Hybrid/ Full-electric 4-9 Passengers 	<ul style="list-style-type: none"> Full-electric 2 Passengers 	<ul style="list-style-type: none"> Full-electric 4-6 Passengers
Engine supplier	Siemens/ MagniX	N.a.	N.a.	N.a.	N.a.	Rolls-Royce.
Flying range	650 miles	100 miles	335 miles	800 miles	110 miles	310 miles
Earliest entry into service	2021	2020	2027	2022	N.a.	2030
Management experience	<ul style="list-style-type: none"> Chairman: founded 10 startups CEO: physicist 	<ul style="list-style-type: none"> CEO: 7 years program mgmt at Northrop Grumman 	<ul style="list-style-type: none"> CEO: founded 3 startups 	<ul style="list-style-type: none"> CEO: Airbus CTO for 10 years; lead on E-Fan project 	<ul style="list-style-type: none"> Not applicable 	<ul style="list-style-type: none"> Not applicable
UBS assessment ⁽¹⁾	+	+	+	++	++	++

Source: UBS analysis, company information

Note: (1) Zunum Aero ran out of cash during the summer 2019 ([Forbes](#)); (2) Criteria include: credibility related to company/management experience, technology and overall challenge for the respective companies.

Alternative bio fuels: most realistic option for long-haul flights

In the US, California and Oregon have introduced Low Carbon Fuel Standards (LCFS) for Transportation. Colorado is just starting to explore an LCFS scheme too. Even more recently (as of Friday 26th September 2019), California has submitted to a public consultation more favourable standards which had a positive outcome. The LCFS credits generated by producers of low-carbon fuels have been increased by 5-10%. This should stimulate the production and use of alternative bio fuels. Alternative biofuels (Neste is already producing such a product and has a distribution agreement with BP) seems to be the most likely technology for long-haul travel. Alternative fuels generate fewer emissions whilst being "produced" compared to fossil fuels; the airplane flying and combustion emits very similar levels of CO₂ to jet fuel.

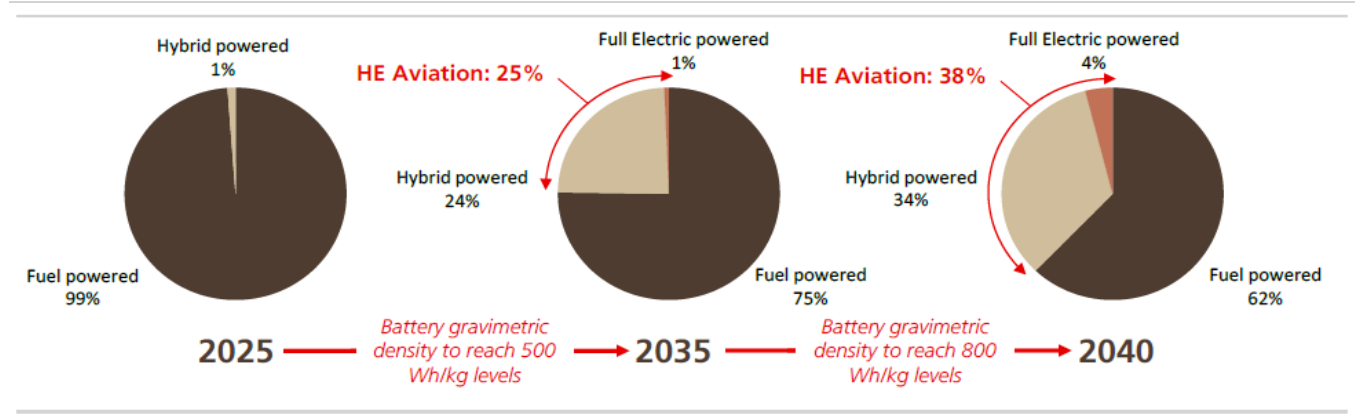
California to make bio-fuels credits more attractive, Oregon, Colorado other States with LCFS schemes initiatives

Bottle neck to Hybrid planes remains the battery

In our in-depth Q-Series note we had some sceptical feedback on our 2028 timeline to introduce a partially electric 70-100 seater plane. However the certification process of the hybrid propulsion system on such a plane should not take more than two and half years based on our discussions with several experts (Glen Bowling, Ampaire, Rolls-Royce, Easyjet), so it is mostly all focused around the right battery technology - energy vs weight. Over the next three years we could see some retrofitted small hybrid planes (<19 seaters) and helicopters taking to the sky: VoltAero, Fresson (Cranfield Aerospace Solutions), Ampaire. These are generally

powered with current battery technologies with liquid lithium-ion cell packs which can deliver 200kW/hr, and they will pioneer the certification of hybrid technology within the Part23 of the FAA/EASA plane certification chapter. Larger planes from 20 seats have a more stringent certification based on Part25 where catastrophic failures must be extremely improbable (the upper limit for the Average Probability per Flight Hour for Catastrophic Failure Conditions of 1×10^{-9}).

Figure 17: The UBS HE Aviation technology road map to 2040



Source: UBS estimates

For larger planes batteries are unlikely to be the ultimate solution due to energy density limitations and weight. The industry is also exploring fuel cells and liquid hydrogen uses are gaining support, but in our view these are very early days. These technologies could be available for commercial application in 15+ years. In our view, the consumer's concerns around climate change will further increase particularly in developed markets. We reiterate our view that the Aviation industry needs to implement solutions to reduce climate change before 2035.

We have discussed with several experts and most of them were convinced that the battery technology will continue to improve rapidly over the coming years, providing more options suited to Aviation. Currently batteries are based on a chemistry of nickel, manganese and cobalt, with an increased use of nickel as it is a high energy system and safe. Ampaire CEO thinks that the **gains on energy density have been close to 3-5% per year, but it could be up to 7% pa with strong investment**. Today lithium-ion cells produce c.200 kWh but this could go up to 400kWh per pack. Overall this will remain of limited appeal versus the energy density 10x superior to fuel, hence why full-electric large planes are unlikely to be introduced before 2030-35.

The major bottleneck for batteries in Aviation remains the very high safety standards, and even more so after the recent Boeing incidents. We held a battery expert call with Glen Bowling a few weeks ago, discussing all these aspects. According to Glen, who has spent a bit less than 30 years at Saft batteries (a company owned by Total), one of the leading battery manufacturers for the aviation industry. In 2018 Saft built an Alliance with other European partners to launch an ambitious program of research, development and industrialization for new generations of batteries focusing on advanced high-density Li-ion and Solid-State technology. The program addresses all market segments, such as electro-mobility (EV, e-Bus, Railway, Marine, Aviation), energy storage (ESS) and specialty industries.

Toyota Prius 1st generation had 20km of all electric range in 2012. The 2nd generation could do 40km in 2016.

Aerospace industry has introduced technologies gradually, step changes are rare on "critical" equipment - number of pilots in cockpit, share of composite structures

Aviation sector needs to partner on technologies backed by other market segments – the truck industry for example is keen to accelerate solid-lithium batteries as they run for longer distances than electric cars

Solid state batteries can provide much more density than current battery technologies and are extremely safe as there is no free electrolyte in the battery (ie safer than lithium-ion for which the FAA has authorised a limited and highly protected use of on the back of the Ethiopian Airlines 787 that caught fire at LHR airport). Today most battery companies and start-ups are working on solid state batteries based on polymers or ceramic electrolytes. While polymers are far cheaper, they don't offer great conductivity, and therefore the battery would lack the required power/density. On the other hand, ceramic gives you higher conductivity, but is more complex and hence more expensive to manufacture as of today. In both cases, the battery chemistry reduces dependency on rare materials which is also a very important strategic angle.

Solid-state technology could increase battery volumetric energy from around 600 watt-hours per litre (Wh/L) to as high as 1,200 Wh/L. This type of battery could provide a far higher energy density vs lithium-ion, enough to lift an aircraft. However, solid state batteries are in their infancy and could take up to 10 years to be commercialised for Aviation according to Glen, as the cost challenge needs to be addressed (i.e. ceramic conductors) and the appropriate chemistry still needs to be established to get to the best compromise of power and safety. Glen thinks there are two chemistries as of today that could be in line with the aviation safety requirements: i) iron phosphate (low energy, and heavier than li-ion), ii) manganese phosphate (energy density 20-30% higher but in very early stage of lab testing). In both cases, fast charging features would need to be improved. Sulfur-based and carbon based could also be good chemistry alternatives, however it will take time to determine which one is the most appropriate. Finally, the airframers will have to determine what ratios of electric/fuel they are willing to target in order to develop the most appropriate battery technology.

**UBS Evidence Lab is a sell-side team of experts, independent of UBS Research, that work across 12 practice areas and 45 specialized labs creating insight-ready datasets. The experts turn data into evidence by applying a combination of tools and techniques to harvest, cleanse, and connect billions of data items each month. Since 2014, UBS Research Analysts have utilized the expertise of UBS Evidence Lab for insight-ready datasets on companies, sectors, and themes, resulting in the production of over 6,000 differentiated UBS Research reports. UBS Evidence Lab does not provide research, investment recommendations, or advice, but provides insight-ready datasets for further analysis by UBS Research and by clients.*

UBS Evidence Lab conducted an online survey among a representative panel of consumers across the US, UK, France and Germany from 26th July to 6th August, 2019. Representation was on the basis of gender, income and location of residency. In total 6097 consumers completed the survey with approximately 1/4 in each of the four countries (US N=1509; UK N=1541; France N=1522; Germany N=1525). The margin of error for responses is between +/-0.9 (total sample) and +/-1.9 (individual countries) at 90% confidence level.

This report leverages the following UBS Evidence Lab asset: Europe & US Travel Consumer Survey.

Wave 4 results reflect our survey of 6241 respondents, conducted from 27th July to 9th August 2018.

Wave 3 results reflect our survey of 6,019 respondents conducted from 27th March to 11th April 2017

Valuation Method and Risk Statement

Valuation: In the Aerospace sector, we set out 12-month forward price targets primarily based on a discounted cash flow analysis, which we believe provides a comprehensive and longer-term view of a company's potential earnings growth. To add greater depth to the analysis, we apply both medium- and long-term assumptions around the growth rate and WACC. Additionally, we sanity-check our results using a combination of forward multiples, including P/E, EV/EBITDA and FCF yield.

Risk statement: The aerospace industry faces a number of risks, including weakening global economies as well as exogenous events, which can lead to a decrease in passenger and/or freight demand as well as demand for business aircraft. Lower demand can impact aircraft deliveries and related aircraft services, which could significantly impact our companies' sales and earnings. The defence industry faces a number of risks, including a slowdown in defence spending as well as exogenous events, which can lead to lower customer demand, both domestically and internationally. Lower defence spending and lower customer demand can impact contract profiles and product delivery/programme execution, which could significantly impact our companies' sales and earnings.

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12-Month Rating	Definition	Coverage ¹	IB Services ²
Buy	FSR is > 6% above the MRA.	45%	30%
Neutral	FSR is between -6% and 6% of the MRA.	40%	28%
Sell	FSR is > 6% below the MRA.	15%	20%
Short-Term Rating	Definition	Coverage ³	IB Services ⁴
Buy	Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%
Sell	Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%

Source: UBS. Rating allocations are as of 30 June 2019.

1: Percentage of companies under coverage globally within the 12-month rating category.

2: Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.

3: Percentage of companies under coverage globally within the Short-Term rating category.

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Company Name	Reuters	12-month rating	Short-term rating	Price	Price date
Airbus ^{7, 18}	AIR.PA	Buy	N/A	€119.00	27 Sep 2019
Boeing Co. ^{7, 16}	BA.N	Buy	N/A	US\$382.86	27 Sep 2019

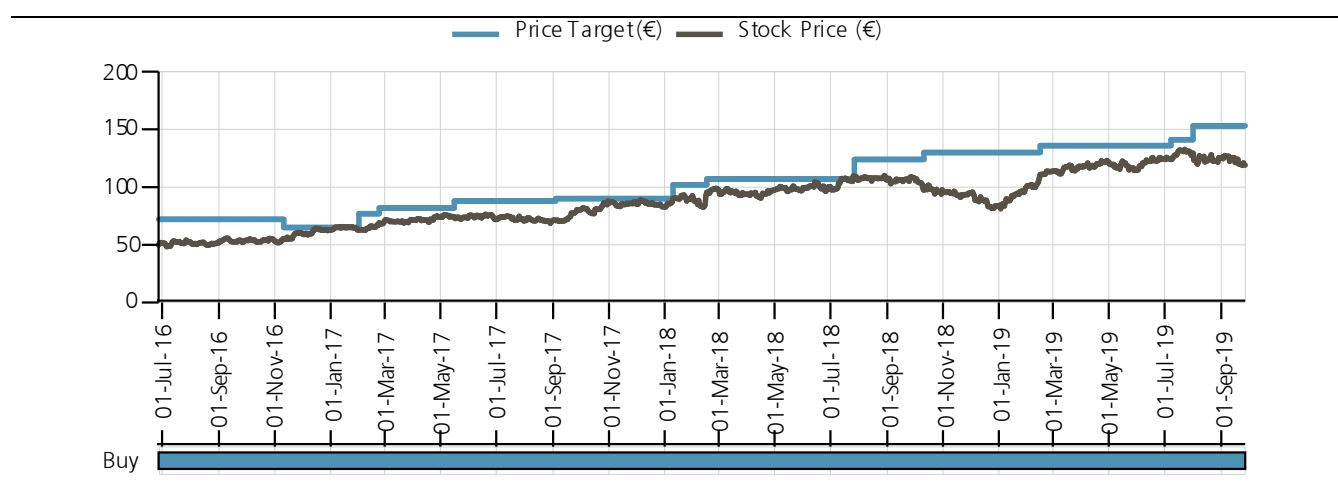
Source: UBS. All prices as of local market close.

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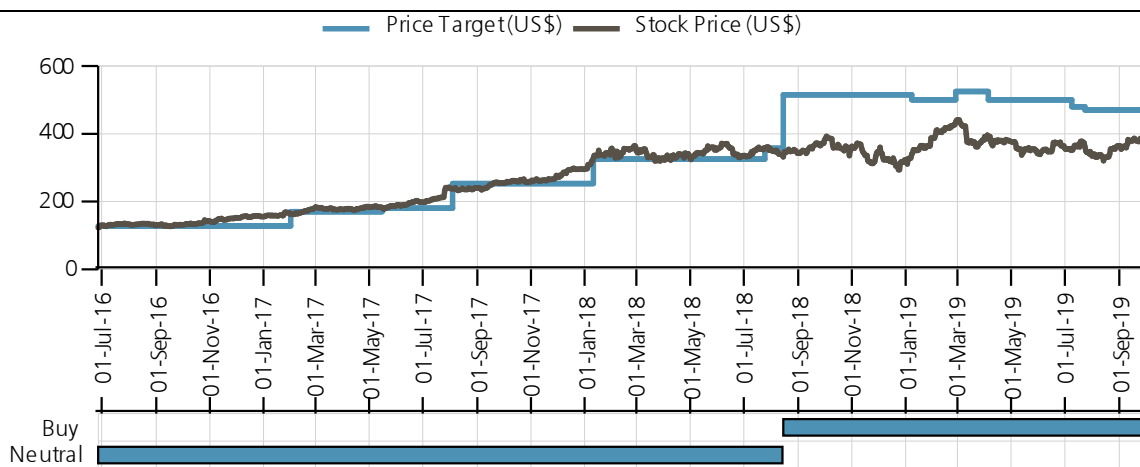
Airbus (€)



Date	Stock Price (€)	Price Target (€)	Rating
2016-06-27	49.92	72.0	Buy
2016-11-11	54.76	65.0	Buy
2017-02-01	63.1	77.0	Buy
2017-02-23	69.05	82.0	Buy
2017-05-16	74.19	88.0	Buy
2017-09-04	71.09	90.0	Buy
2018-01-10	90.27	102.0	Buy
2018-02-16	95.53	107.0	Buy
2018-07-27	109.2	124.0	Buy
2018-10-11	97.33	130.0	Buy
2019-02-15	110.98	136.0	Buy
2019-07-08	123.92	141.0	Buy
2019-08-01	129.42	153.0	Buy

Source: UBS; as of 27 Sep 2019

Boeing Co. (US\$)



Date	Stock Price (US\$)	Price Target (US\$)	Rating
2016-06-27	122.7	128.0	Neutral
2017-02-01	163.97	170.0	Neutral
2017-05-16	182.7	180.0	Neutral
2017-08-04	237.71	253.0	Neutral
2018-01-11	328.12	325.0	Neutral
2018-07-25	355.92	357.0	Neutral
2018-08-15	331.76	515.0	Buy
2019-01-08	340.53	500.0	Buy
2019-02-27	435.44	525.0	Buy
2019-04-05	391.93	500.0	Buy
2019-07-09	353.09	480.0	Buy
2019-07-24	361.43	470.0	Buy

Source: UBS; as of 27 Sep 2019

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